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Contract W7714-4-9858

DIFFERENTIAL GLOBAL POSITIONING SYSTEM

- DESIGN DOCUMENT -

and

- USER'S MANUAL -

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August 31, 1995

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DIFFERENTIAL GLOBAL POSITIONING SYSTEM DESIGN DOCUMENT

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August 31, 1995

REVISION SHEET

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GLOSSARY

BIOS:	*Basic Input/Output System.*
CPU:	*Central Processing Unit.*
DGPS:	*Differential GPS.* The combination of the Mobile GPS carried by the target, and the Fixed GPS located in the DLCS.
DLCS:	*Data Logger and Control System.* The VME-based data acquisition system.
DOS:	*Disk Operating System,* from Microsoft.
EARS:	*Experimental Array Radar System.*
GPS:	*Global Positioning System.*
GPS-VME:	VME-based GPS Time and Frequency Board, from TrueTime. Integrated in the DLCS.
GPS-XL:	Stand-alone GPS Time and Frequency Board, from TrueTime. Integrated in the Mobile GPS.
GUI :	*Graphical User Interface.*
HK68/V4F:	68040-based single board computer, from Heurikon. Used by the DLCS.
OS-9:	Operating system running on the HK68/V4F, from Microware.
PC:	*Personal Computer.*
UTC:	*Universal Time Coordinated.*

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1. INTRODUCTION

1.1 DOCUMENT SCOPE

This document describes the architecture of the Differential Global Positioning System (Differential GPS) to be used in the Data Logger and Control System (DLCS) of the Experimental Array Radar System (EARS) project. The document includes a high-level description of the system operation, the hardware components and the software programs. The Differential GPS has been developed for the EARS project, as required in Task 3 of contract W7714-4-9858. It has been designed according to the Project Plan and MultiDev's proposal, reference [1].

1.2 PURPOSE OF THE DIFFERENTIAL GPS

The purpose of the Differential GPS is to measure and record the location, in both time and space domains, of the radar target during EARS' trials. This information can be used afterwards, along with the collected data, to relate the time with the position of the target, and ultimately to evaluate the performances of the radar algorithms.

2. DIFFERENTIAL GPS DESCRIPTION

A Differential Global Positioning System will be installed into EARS: one GPS will reside on the VMEbus and will indicate the position of the radar, and the other GPS will be located beside the radar target during the trials. The locations generated by both GPS' will be copied to a floppy within the DLCS. Figure 2-1 shows the Differential GPS architecture.

The Differential GPS is comprised of two GPS systems:

- A fixed GPS, residing on the Data Logger and Control System
- A mobile GPS, close to the target during the experiments.

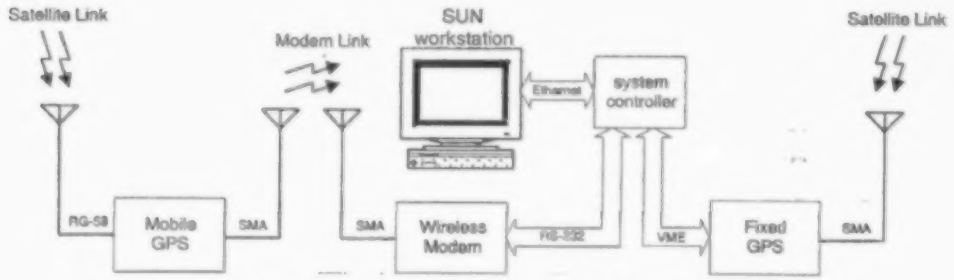

Figure 2-1 Differential GPS Architecture

Both GPS' are used by EARS to obtain an accurate location of the target. During a trial, both GPS systems periodically provide to the EARS DLCS their location in time and space domain, derived from the Coarse Acquisition Link 1 signals received from the NAVSTAR GPS satellites. The GPS task, which runs on the DLCS' CPU board, combines the two GPS locations and computes the position of the target relative to the radar to obtain a more accurate location of the target.

The resulting computed position should be more precise than the positions obtained from the two GPS'; the errors get cancelled during the calculation, since the two GPS positions come from the same set of satellites (assuming that the two GPS' are not too far apart).

The DLCS stores on a floppy disk the results obtained for all the positions transmitted by the two GPS' during the trial. The file therefore contains the dynamic tracking information (time and position) of the target during the whole trial.

2.1 FIXED GPS DESCRIPTION

Figure 2-2 shows the Fixed GPS components, and how they interconnect together. The Fixed GPS has been implemented by adding a GPS-VME card to the DLCS. This card resides on the VMEbus along with the Heurikon system controller. An antenna is connected to this board and must be in line-of-sight with GPS satellites to ensure proper operation.

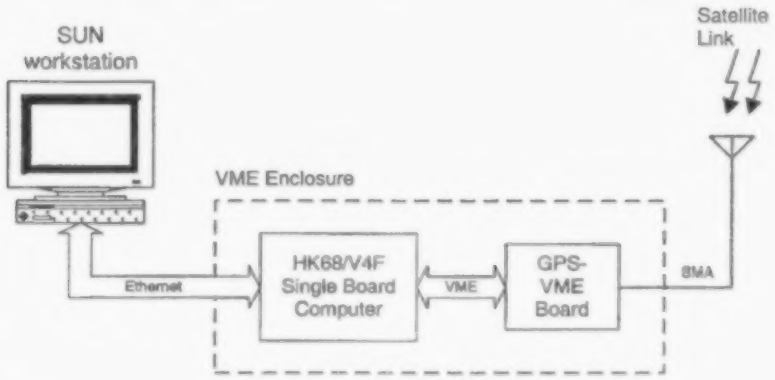

Figure 2-2 Fixed GPS Architecture

The GPS-VME is initialized and configured by the SUN workstation via the system controller. Once configured, the GPS-VME starts collecting information from the GPS satellites and calculates its current position. When it is in operation, the system controller issues a command to the GPS to obtain the current time and position. This operation is performed once per second. The data block is then stored on disk.

2.1.1 GPS-VME

The first GPS-VME initialization takes approximately 24 hours. During that time, the GPS-VME is in initialization mode and the positioning data is not accurate. After this period, the GPS-VME enters its operational mode and can generate accurate measurements (less than 10 metres).

Another technique that may be used to initialize the GPS is to first enter the known system coordinates which will provide an accurate position to the GPS-VME from the beginning. With such information, the GPS-VME will be able to become operational shortly after the exact position is entered (less than 15 minutes).

If no satellites are in line of sight with the GPS antenna, there will be no calculations performed by the GPS-VME and the position data will not change.

If the GPS-VME moves significantly (more than 1 kilometre), it may lose its positioning information. Once the position is lost, a 24 hour period is necessary to relocate the GPS, or known and accurate coordinates have to be re-entered.

Each time the system is powered up, the GPS-VME will determine its current position. If the system moved less than one kilometre, the system will be operational after a short initialization period (15 minutes). If the system moved more than one kilometre, a complete initialization process is required.

2.2 MOBILE GPS DESCRIPTION

The mobile GPS is a stand-alone system located beside the radar target which moves with it and constantly indicates the new position of the target. Figure 2-3 shows the Mobile GPS equipment and its interconnection. The Mobile GPS is comprised of:

- A GPS-XL board with its antenna
- A wireless modem with its antenna
- A PC-compatible single-board computer.

Also part of the mobile GPS is a second wireless modem, located near the SUN workstation. It receives the signals from the first wireless modem within the mobile GPS and enables communication between the Mobile GPS and the SUN workstation.

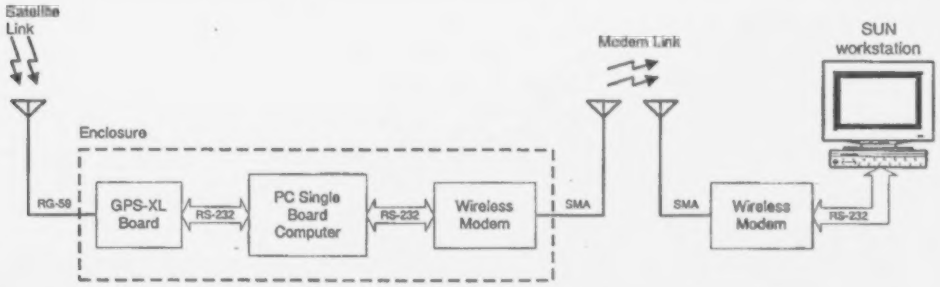

Figure 2-3 Mobile GPS Architecture

A PC based single-board computer provides the processing power and system control required by the Mobile GPS. The PC board uses two RS-232 links to communicate with the GPS board and the wireless modem. The GPS board will be configured to evaluate its current position once per second. The position, along with the corresponding time, will be transferred serially to the PC, then from the PC to the wireless modem. This information then gets transmitted by modem over the air to the other wireless modem and the SUN workstation.

2.2.1 GPS-XL

The GPS-XL board operation is similar to the GPS-VME board.

- The initial positioning period (24 hours) is also required for the GPS-XL, unless a known accurate position can be entered.
- The antenna must be in line-of-sight with GPS antennas to calculate new positions.
- At power-up, the GPS-XL must be close to its last calculated position in order to initialize quickly.

In addition, the GPS-XL will be configured to generate positions while it is moving. This mode is called DYNAMIC mode, as opposed to the GPS-VME which will not move and will be in STATIC mode. Once configured in dynamic mode, the GPS-XL

can move more than one kilometre and still provide accurate coordinates. Note however, that the antenna must be in contact with GPS satellites to calculate its new position. If line-of-sight cannot be established with the satellites, it is possible that the GPS-XL will lose its position and will have to recalculate its new position when it can access the GPS satellites at a later time.

2.2.2 Wireless Modem

The wireless modem connects the mobile GPS unit to EARS and is responsible for transmitting the position data generated by the mobile GPS. Since the modem is Hayes compatible, it is simply initialized by sending the "AT" command, which should be acknowledged by an "OK" response to the PC. The modem is then configured by putting it into direct transfer mode which will automatically transfer all data received by the modem from the PC.

After the modem is configured, it simply passes all the information directly to the wireless link and to the other modem connected to the SUN workstation.

2.2.3 Single-Board Computer

The single-board PC is a stand-alone computer with two serial ports, one for the GPS board and the second for the wireless modem. The PC is responsible for initializing and configuring the GPS-XL and the wireless modem, acquiring the position data from the GPS-XL, transmitting data to the wireless modem, and monitoring the mobile GPS unit.

The PC initializes the GPS-XL by ensuring that the GPS is operational, i.e. that it can generate accurate coordinates. The PC constantly monitors the GPS to ensure that the initial positioning process is completed. Once it is initialized, the PC configures the GPS-XL to generate a set of coordinates every two seconds.

The PC initializes the wireless modem and establishes the communication with the SUN workstation. Control and status commands are exchanged to confirm the validity of the link. After initialization, the PC receives data from the GPS-XL which is directly transferred to the wireless modem for transmission.

Other activities include the monitoring of the unit. The PC can send a status message when requested by the DLCS.

3. HARDWARE DESIGN

The Differential Global Positioning System is composed of two units:

- the fixed GPS unit which includes the GPS-VME only and directly connects to the VMEbus. The boards fits within the same VME enclosure as the system controller, and is limited to software configuration and operation. This board is described in the Software Design section.
- the mobile GPS unit which includes the GPS-XL, the stand-alone PC, one wireless modem, a power supply board and an enclosure. In addition a second wireless modem is connected to the SUN workstation. The hardware configuration of the mobile GPS unit is described below.

3.1 MOBILE GPS UNIT

The hardware configuration of the mobile GPS unit is shown in Figure 3-1 below. The unit is composed of:

- a PC based stand alone controller card which provides all the communications links to control the other elements.
- a GPS-XL, a stand alone GPS unit which communicates with the PC via a factory set serial port.
- a wireless modem which communicates with the PC via a serial link.
- a power supply card which converts the incoming supply to voltages compatible with the PC, GPS and modem requirements.
- a waterproof enclosure containing all the above elements and providing connections to the power sources and the antennas.

3.1.1 Stand Alone PC

The stand-alone PC is a MicroPC 6012 from Octagon Systems. It has 2 serial ports and the program is downloadable to a non-volatile memory. There is no hardware design requirements for the stand-alone PC.

Three connections to the PC are necessary:

- the serial port to the GPS-XL
- the serial port to the wireless modem
- the power supply cable coming from the power supply board. This cable also includes a battery low signal coming from the power supply board.

3.1.2 GPS-XL

The GPS-XL is a stand alone GPS unit manufactured by TrueTime. There is no hardware design requirements for the GPS-XL.

Three connections to the GPS-XL board are necessary:

- the serial cable coming from the PC
- the power supply cable coming from the power supply board.
- the antenna cable which connects the GPS-XL to an SMA connector on the enclosure (and to the antenna outside the enclosure)

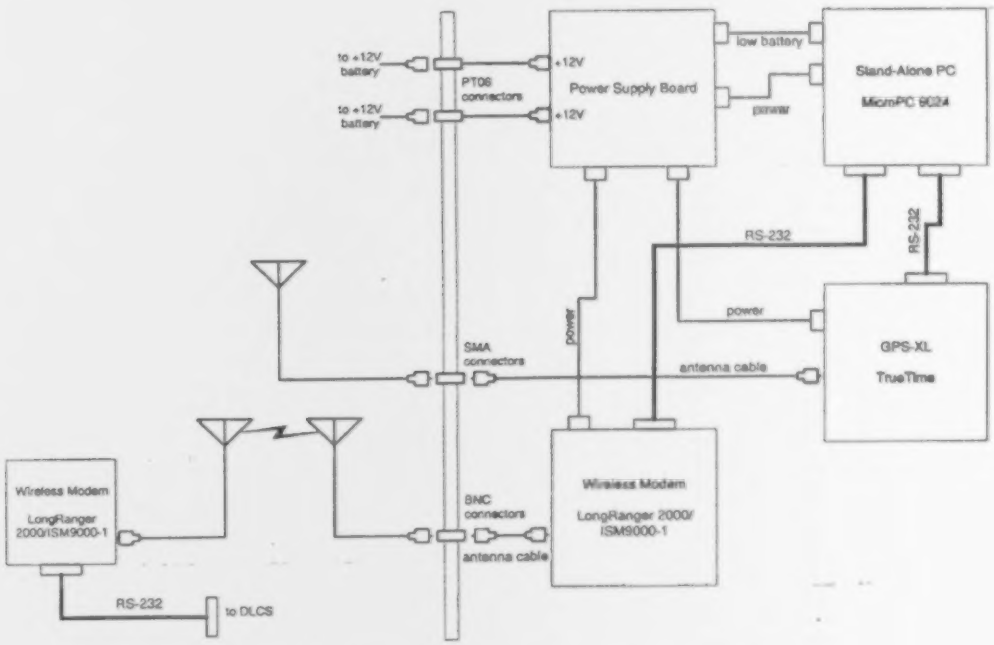

Figure 3-1 Mobile GPS Hardware Configuration

3.1.3 Wireless Modems

The LongRanger 2000/ISM900-1 Spread Spectrum modems are manufactured by Utilicom. One modem is located inside the mobile GPS unit. The other is located beside the SUN workstation. There is no hardware design requirements for the GPS-XL.

Three connections to the modem inside the mobile GPS unit are necessary:

- the serial cable coming from the PC
- the power supply cable coming from the power supply board
- the antenna cable which connects the GPS-XL to a BNC connector on the enclosure (and to the antenna outside the enclosure)

Three connections to the modem beside the SUN workstation are necessary:

- the serial cable coming from the SUN
- the power cord coming from the AC power supply delivered with the modem
- the antenna cable which directly connects to the antenna

3.1.4 Power Supply Board

The Power Supply Board will be designed by MultiDev. It will generate all power to the devices from a single +12V battery source (see Figure 3-2).

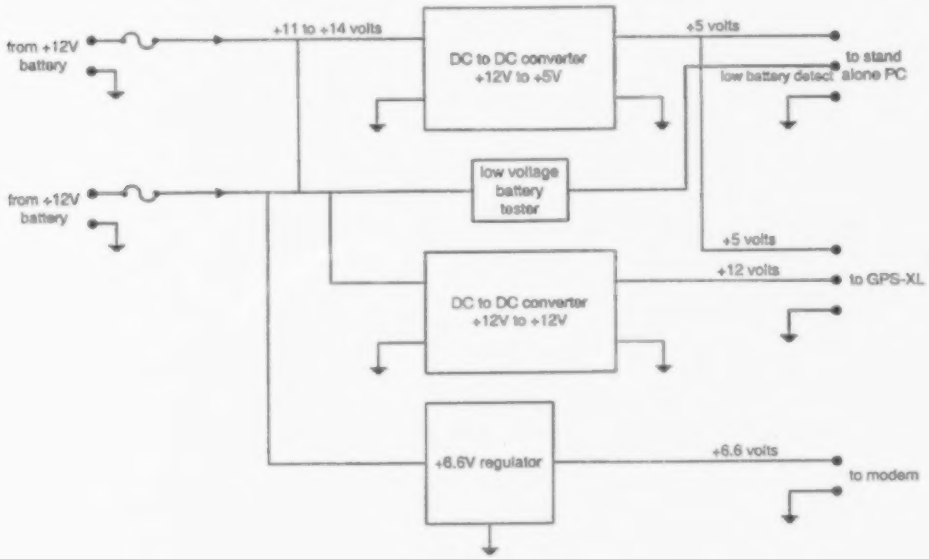

Figure 3-2 Power Supply Board Configuration

It is composed of the following:

- two +12V inputs for connection to two +12V batteries. Each input has a protection diode for inverse voltage. The unit operates with only one +12V battery. Two inputs are provided to switch from one battery to another without losing power to the unit. The acceptable voltage range is from +10V to +14.5 V.
- if the voltage drops below +10V, a battery low circuit sends a signal to the PC.
- a DC-to-DC converter (+12Vdc to +12Vdc) supplies voltage to the GPS-XL. The current requirement is less than .5A.
- a DC-to-DC converter (+12Vdc to +5Vdc) supplies voltage to the PC and the GPS-XL. The combined current requirement is less than 1.5A
- A voltage regulator supplies voltage to the wireless modem. The power requirement is +6.6V @ 1A. A heat sink will be tied to the regulator.

- The board also contains protection fuses. An estimated total of 2.5A @ +12V will be required. The fuses should be rated at 5A. Refer to Table 3-1 below:

Table 3-1 Mobile GPS Unit Supply Requirements

ELEMENT	VOLTAGE	CURRENT	INPUT CURRENT (@12V, estimated)
Stand Alone PC	+5V	0.3A	0.2A
GPS-XL	+12V	0.1A	0.15A
	+5V	0.75A	0.5A
Modem	+6.6V	1A	1A
TOTAL			**1.85A**

3.1.5 Enclosure

A waterproof 20x24 enclosure manufactured by Hammond will house all the components.

The enclosure provides four external connections:

- two similar connections to external +12V batteries. Waterproof PT06 connectors are provided on the enclosure. Inside the enclosure, the PT06s are connected to the power supply board via short cables.
- one connection to the GPS antenna. A waterproof SMA connector is provided on the enclosure for connection to the antenna. Inside the enclosure, the SMA is connected to the GPS-XL via a short coaxial cable.
- one connection to the wireless modem antenna. A waterproof BNC connector is provided on the enclosure for connection to the antenna. Inside the enclosure, the BNC is connected to the modem via a short coaxial cable.

4. SOFTWARE DESIGN

The Differential GPS is controlled by three sub-systems:

- The SUN workstation, which controls both the Fixed GPS and the Mobile GPS, and provides the user interface
- The PC single-board computer, within the Mobile GPS enclosure, which interfaces the GPS-XL board to the SUN
- The HK68/V4F single board computer, within the DLCS enclosure, which interfaces the GPS-VME board to the SUN.

4.1 SUN WORKSTATION APPLICATION PROGRAM

The Differential GPS Program for the SUN consists of a Graphical User Interface (GUI) window, which provides a user interface to control the operation of both the Fixed GPS and the Mobile GPS.

The GPS window is responsible of configuring its wireless modem and both GPS'. It also allows the user to reconfigure certain parameters for both GPS'.

4.1.1 Modem Configuration

All the operating parameters of the modem have already been configured and saved in its non-volatile RAM. Therefore they do not require to be issued again.

4.1.2 Fixed GPS Configuration

After power-up of the Fixed GPS, the SUN workstation sends the configuration messages listed below:

- The UTC time zone offset where the DLCS is located
- The GPS-VME operational mode, either:
  - AUTO, if the DLCS position is expected to be fixed, and that position is either inaccurately known or totally unknown. Once the position is accurately known, the unit goes automatically in the KNOWN operational mode.
  - SURVEY if the DLCS position is totally unknown
  - DYNAMIC if the DLCS is constantly moving
  - KNOWN, if the GPS position is accurately known.
- The position of the DLCS, if known

4.1.3 Mobile GPS Configuration

After power-up of the Mobile GPS, the SUN workstation sends the configuration messages listed below. A detailed description of these messages can be found in [3].

- The UTC time zone offset where the Mobile GPS is located (message number 01).
- The GPS-XL operational mode (message number 53), either:

- AUTO, if the Mobile GPS position is expected to be fixed for 24 hours, and that position is either inaccurately known or totally unknown. After 24 hours of position averaging, the unit goes automatically in the TIME operational mode.
- SURVEY STATIC, if the starting position is known, and if the Mobile GPS is moved only for transportation purposes, with its position remaining fixed at the new location during the trial.
- SURVEY DYNAMIC, if the starting position is known, and if the Mobile GPS is constantly moving during the trial.
- TIME, if the Mobile GPS position is accurately known and the unit is not moved by more than 1 km. If the unit is moved by more than 1 km, it returns automatically to the AUTO mode.

- If known, the approximate position of the Mobile GPS (message number 50) if operating in the two SURVEY modes (STATIC or DYNAMIC), or the average position of the Mobile GPS (message number 56) if operating in the AUTO or TIME modes.
- The request to the GPS-XL to issue time and position once per second (special message). This message puts the Mobile GPS in an operational mode.

4.1.4 User Configuration

The GPS window allows the user to configure both GPS', by means of graphical buttons and indicators. The following parameters are user-configurable:

- The UTC time zone offset. This parameter is obtained from the profile file upon starting the window. Once modified by the user, it gets sent to both GPS and stored back in the profile file.
- The operational mode of the GPS'. These parameters are blank upon starting the window, and have to be initialized by the user to activate each GPS.
- The position of the GPS'. These parameters are obtained from the profile file upon starting the window. Once one of them is modified by the user, it gets sent to the corresponding GPS and stored back in the profile file.

When the user reconfigures a Fixed GPS parameter, the SUN asks the HK68/V4F CPU board to stop collecting information from the GPS-VME. The SUN issues the new configuration messages; the GPS Task running on the system controller translates these messages and sets the GPS-VME registers accordingly. Finally the user puts the GPS-VME back to the operational mode by issuing a command.

When the user reconfigures a Mobile GPS parameter, the SUN issues a CONTROL-C character (Hex 03) to put the GPS-XL in the configuration mode, followed by the new configuration messages. Then the user puts the unit back to the operational mode by telling it to issue the time once per second (message number 08).

4.2 FIXED GPS APPLICATION TASK

The Fixed GPS Application Task runs continually on the HK68/V4F CPU board, located in the DLCS enclosure. The purpose of the GPS Task is to allow EARS to support the GPS-VME board, also located in the DLCS enclosure. The Fixed GPS task provides the message interface with the SUN workstation; it also supports access to the GPS-VME registers, through the CPU board's VME short address space. Figure 2-2 shows the Fixed GPS architecture. The GPS-VME registers are detailed in reference [2].

When invoked, the GPS Task first performs a basic configuration of the GPS-VME board. Then the task requests the SUN workstation to issue the user-configurable parameters for the GPS board. Once these parameters have been sent, the SUN tells the GPS Task to become operational.

4.2.1 GPS-VME Configuration

At start-up, the GPS Task puts the GPS-VME in the GPS Synchronized Generator mode. Then the GPS Program requests EARS to configure the GPS-VME with the user-defined parameters. The SUN receives the request, and answers by sending the required configuration messages.

4.2.2 GPS Task Normal Operation

Once operational, the GPS Task collects at every second both the position and the time from the GPS-VME board. Once obtained, the information is forwarded the SUN workstation through the Ethernet link.

4.3 MOBILE GPS APPLICATION PROGRAM

The Mobile GPS Application Program runs continually on the PC single-board computer after power-up of the unit, once BIOS and DOS initializations are done. The purpose of this program is to allow EARS to support the GPS-XL board through the wireless modem. The Mobile GPS Program communicates with the GPS board and the modem by means of two serial ports, as shown in Figure 2-3.

When invoked, the Mobile GPS Program first tries to establish communication with the GPS board. Then the program requests the SUN workstation to issue user-configurable parameters for the GPS board. Once these parameters have been sent, the SUN tells the GPS Program to become operational.

4.3.1 Single-Board Computer Configuration

The single-board computer initializes itself to operate of both the GPS-XL board and the modem through their serial port. The single-board computer's serial ports are initialized, in order to enable RS-232 communication with the modem and with the GPS board.

4.3.2 Modem Configuration

All the operating parameters of the modem have already been configured and saved in its non-volatile RAM. Therefore they do not require to be issued again.

4.3.3 GPS-XL Configuration

The program sends the GPS board a CONTROL-C character (Hex 03) to prepare the unit for configuration, and issues some of the configuration messages listed below. The number of each message is given in the GPS-XL convention; the details can be found in [3].

- The 12/24 hour time format to be used by the GPS-XL (message number 02)
- The four thresholds to indicate the quality of the time obtained from the satellites signals (message number 05)
- The time output format, with the option to receive or not the following fields: day, hours, minutes, seconds, milliseconds, and quality (message number 11)
- The GPS-XL antenna cable delay (message number 51)
- The altitude units, meters or feet, to be used by the GPS-XL when issuing the altitude derived from the satellites signals (message number 55).

Afterwards, the GPS Program requests EARS to configure the GPS-XL with the user-defined parameters, through the modem. The SUN receives the request, and answers by sending the required configuration messages.

4.3.4 GPS Program Normal Operation

Once operational, the GPS Program collects every two seconds both the position and the time from the GPS board. The information is then forwarded to the wireless modem and to the DLCS. Therefore, the GPS Program receives the current time and position from the GPS-XL board every two seconds (special message).

This special message triggers the GPS Program to read the approximate position (message number 50) when running in either SURVEY STATIC mode or SURVEY DYNAMIC mode, or the average position (message number 56) when running in either the AUTO mode or the TIME mode. Both the time and the position are transmitted to EARS through the wireless modem.

4.4 WIRELESS LINK PROTOCOL

The purpose of the two wireless modems is to allow data exchanges between the SUN workstation and the single-board PC computer.

4.4.1 Message Format

All the messages on the wireless link are the same as those normally sent to the GPS-XL. The messages between the PC board and the GPS-XL follow the format described in [3].

4.4.2 Message Protocol

A communication process starts when the transmit end issues a message to the attention of the other end. The receiving end responds to each message by sending an acknowledge (ACK). This protocol is done internally by the wireless modems and is transparent to the user.

5. REFERENCES

[1] *Development of an Enhanced Signal Processing Data Acquisition and Display System,* MultiDev JDL Communications Inc., June 1995.

[2] *Model GPS-VME 560-5604 Operator's Manual*, TrueTime Inc., May 1993.

[3] *Model GPS-XL 87-625 Operator's Manual*, TrueTime Inc., May 1995.

[4] *LongRanger 2000/ISM900-1 Spread Spectrum Modem Operator's Manual*, Utilicom Spread Spectrum Communications.

[5] *LongRanger Operation and Communication Protocol Specification,* Utilicom Spread Spectrum Communications, January 1995.

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A Differential Global Positioning System will be installed into EARS: one GPS (the fixed GPS) will reside inside EARS and will indicate the position of the radar; the other GPS (the mobile GPS) will be located beside a radar target during trials and will provide position of the mobile target.

The purpose of the Differential GPS is to measure and record the location, in both time and space domains, of the radar target during EARS' trials. This information can be used afterwards, along with the collected data, to relate the time with the position of the target, and ultimately to evaluate the performances of the radar algorithms.

This document describes the architecture of the Differential Global Positioning System (Differential GPS) to be used in the Data Logger and Control System (DLCS) of the Experimental Array Radar System (EARS) project. The document includes a high-level description of the system operation, the hardware components and the software programs.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (technically meaningful terms or short phrases that characterize a document and could be helpfu in cataloguing the document. They should be selected so that no security classification is required. Identifiers such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus. e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus-identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

EARS, Experimental Array Radar System
DATA ACQUISITION
REAL TIME PROCESSING
GLOBAL POSITIONING SYSTEM (GPS)
DIFFERENTIAL GLOBAL POSITIONING SYSTEM (DGPS)
VMEBUS
SUN WORKSTATION
WIRELESS MODEM
SINGLE BOARD COMPUTER
STATIC AND DYNAMIC SURVEY
DIGITAL SIGNAL PROCESSING

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DIFFERENTIAL GLOBAL POSITIONING SYSTEM USER'S MANUAL

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REVISION SHEET

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GLOSSARY

AtoD:	*Analog to Digital Conversion.*
CPU:	*Central Processing Unit.*
DGPS:	*Differential GPS.* The combination of the Mobile GPS carried by the target, and the Fixed GPS located in the DLCS.
DLCS:	*Data Logger and Control System.* The VME-based data acquisition system.
DOS:	*Disk Operating System,* from Microsoft.
EARS:	*Experimental Array Radar System.*
EPROM:	*Eraseable Programmable Read Only Memory.*
GPS:	*Global Positioning System.*
GPS-VME:	VME-based GPS Time and Frequency Board, from TrueTime. Integrated in the DLCS.
GPS-XL:	Stand-alone GPS Time and Frequency Board, from TrueTime. Integrated in the Mobile GPS.
GUI :	*Graphical User Interface.*
HK68/V4F:	68040-based single board computer, from Heurikon. Used by the DLCS.
LED:	Light Emitting Diode.
OS-9:	Operating system running on the HK68/V4F, from Microware.
PC:	*Personal Computer.*
PCB:	*Printed Circuit Board.*
UTC:	*Universal Time Coordinated.*

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1. INTRODUCTION

This document describes the operation and troubleshooting of the Differential Global Positioning System (DGPS) to be used in the Data Logger and Control System of the Experimental Array Radar System. The document includes a detailed description of how to install the equipment and the software, how to operate the equipment with the user interface installed on the host workstation (SUN workstation), and how to troubleshoot and reconfigure the equipment in case of failure or need to modify its operation.

Please refer to the design document [8] for a detailed description of the system functionality.

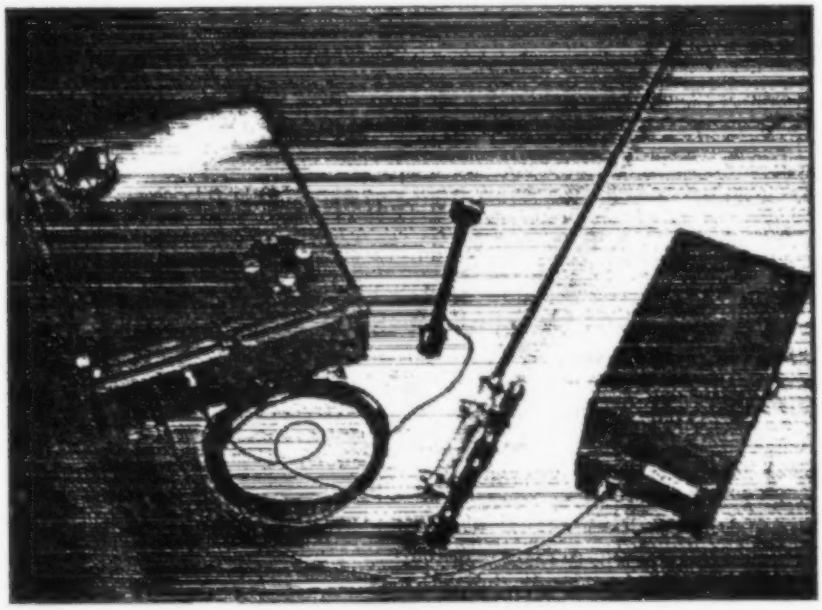


Figure 1-1 The GPS Unit is shown with its antennas and one battery pack

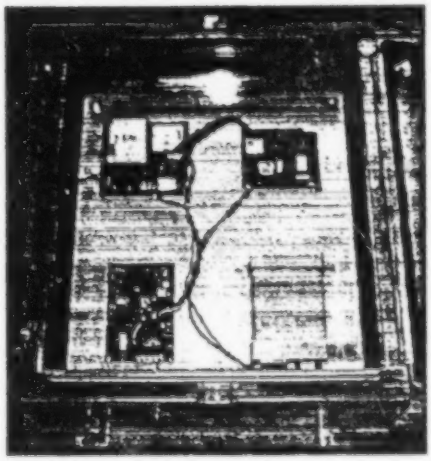


Figure 1-2 Inside view of the GPS Unit

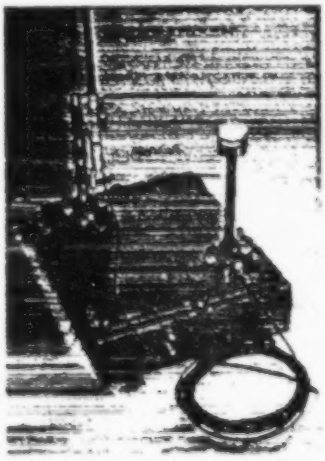


Figure 1-3 The antennas can be mounted on top of the enclosure

2. INSTALLATION

The Differential Global Positioning System is composed of four elements:

- the Mobile GPS (see Figure 1-1) to be installed near the target which provides the target positions sent to the control software via wireless modems,
- the GPS-VME board which resides inside the VME enclosure of the DLCS and provides the reference position,
- the second wireless modem which connects to the host,
- the system controller software which collects the GPS information and provides the real time control and monitoring, and
- the host (SUN workstation) which provides all menus and user interfacing capability.

The installation of the first three element is described below. The software operation is described in the next section.

2.1 MOBILE GPS

The Mobile GPS is a 20" x 24" (510mm x 610mm) enclosure comprised of the GPS-XL board, the Micro PC and the wireless modem. The GPS and wireless modem antennas can be mounted on top of the enclosure (see Figure 1-3) or to other mounting devices located within the range of the GPS and modem cables. The unit is powered by one 12 volt battery pack. A second battery pack can be connected to the unit as a backup source when batteries need to be changed.

2.1.1 Configuring the Mobile GPS

The Mobile GPS does not require any set-up for its operation. The unit has been factory configured to automatically communicate with the remote host via the wireless modem link.

On power-up, the GPS-XL Board is configured by the Micro PC and does not require any set-up.

On power-up, the wireless modem is configured to operate in data mode and does not require any set-up.

On power-up, the Micro PC boots from disk E: (files stored in the Flash EPROM), issues PC initialization messages to the remote host and sends a "GPS UNIT READY" message to the remote host after the initialization routine is complete (4 to 6 seconds after power-up).

If the message "GPS UNIT READY" is <u>not</u> sent to the host, please refer to the troubleshooting section of this manual.

2.1.2 Installing the Battery Pack

One or two battery packs can be connected to the Mobile GPS via the two PT02E connectors at the bottom of the enclosure (see Figure 7-1). The unit can operate with one or two 12-volt battery packs. If two battery packs are connected, the battery pack with the higher voltage will power the Mobile GPS. Two connections are provided in order to switch battery packs without interrupting the Mobile GPS operations.

If the voltage supplied by the battery pack (or both) drops below 10 volts, the Mobile GPS may not operate reliably. When the voltage drops below 10 volts, a second pack should be connected to the Mobile GPS, and the first one should be disconnected and recharged.

2.1.3 Installing the Antennas

The antennas can be mounted on top of the enclosure or onto any other mounting device. Two sockets are provided for quick and easy installation.

2.1.3.1 Mounting the GPS Antenna

The GPS antenna comes with a 12" tube and a base that fits within one of the two sockets on top of the enclosure. Refer to Figure 1-3 and Figure 2-1 for the mounting procedures.

- Remove the tube from the antenna head and connect the GPS cable to the antenna head through the tube via the opening at the bottom of the tube.
- Replace the tube on the antenna head. Make sure that the cable follows the rotation of the antenna head.
- Install the antenna on one Mobile GPS socket.
- Connect the other end of the GPS cable to the BNC connector at the bottom of the Mobile GPS (see Figure 7-1).

Figure 2-1 GPS antenna

If the GPS antenna is installed on another mounting device, make sure that the antenna remains within the range of the cable length.

2.1.3.2 Mounting the Wireless Modem Antenna

The modem antenna comes with all mounting hardware required to install the antenna on top of the Mobile GPS. Refer to Figure 1-3 and Figure 2-2 for the mounting procedures.

- Remove the antenna from its base by removing one screw on the side of the aluminum tube, and connect the modem cable to the antenna through the aluminum tube. The modem cable has one adapter at one end. Use this end.
- Reinstall the antenna base and secure it by inserting the screw on the side of the aluminum tube. The screw should attach to the antenna.
- Mount the antenna on one Mobile GPS socket.
- Connect the other end of the modem cable to the SMA connector at the bottom of the Mobile GPS (see Figure 7-1).

Figure 2-2 Modem antenna

If the modem antenna is installed on another mounting device, make sure that the antenna remains within the range of the cable length.

2.2 GPS-VME Board

The TrueTime GPS-VME is a 6U VME timing board equipped with a GPS engine. This card provides the accurate time and position of the DLCS, for further use by the Differential GPS algorithm. All the GPS-VME parameters, including time and position, are accessible through the VME bus. An alphanumeric display attached to the front panel allows to view some of the GPS-VME parameters.

2.2.1 Base Address Configuration

The GPS-VME operates in the VME short address space of the DLCS' Heurikon CPU board, which ranges from $FF04:0000 to $FF04:FFFF. The GPS-VME itself requires a 256-byte address space. Therefore its base address has been set to $FF04:3000, by setting the 8 DIP switches in U12 as follow:

- switches 1 to 4, 7 and 8 are set to ON
- switches 5 and 6 are set to OFF.

2.2.2 Installation

The GPS-VME has to be installed in slot number 3, starting from the left (this card is a double slot card and occupies slot 4 as well). Once installed, the GPS-VME must be connected to its antenna, to provide accurate time and position.

2.2.2.1 Mounting the GPS Antenna

The GPS antenna comes with a 12" tube like the GPS antenna for the Mobile GPS except that it has no base. Refer to Figure 1-3 as an example for the mounting procedures.

- Remove the tube from the antenna head and connect the GPS cable to the antenna head through bottom of the tube.
- Replace the tube on the antenna head. Make sure that the cable follows the rotation of the antenna head.
- Connect the other end of the GPS cable to the board's face plate via the connector labelled ANTENNA.

Make sure that the antenna remains within the range of the cable length.

2.3 WIRELESS MODEM

The second wireless modem establishes communications between the host and the Mobile GPS. The wireless link is transparent to the user and does not require any configuration.

2.3.1 Installation

The wireless modem connects to the DLCS' serial port that controls the Mobile GPS. For proper installation, a standard modem cable is required.

2.3.1.1 Mounting the Wireless Modem Antenna

The modem antenna comes with all mounting hardware required to install the antenna.

- Remove the antenna from its base by removing one screw on the side of the aluminum tube.
- Install the aluminum tube on a mounting device.
- Connect the long modem cable to the antenna through the aluminum tube.
- Reinstall the antenna base and secure it by inserting the screw on the side of the aluminum tube. The screw should attach to the antenna.
- Connect the other end of the long modem cable to the short modem cable. This short cable is provided to match the modem antenna connector with the long cable.

Make sure that the antenna remains within the range of the cable length.

3. DGPS OPERATION

The EARS Differential GPS application consists of a task running on the DLCS' Heurikon CPU board, and a graphical user interface running on the SUN workstation. The DGPS application requires both programs to run simultaneously on their respective platform.

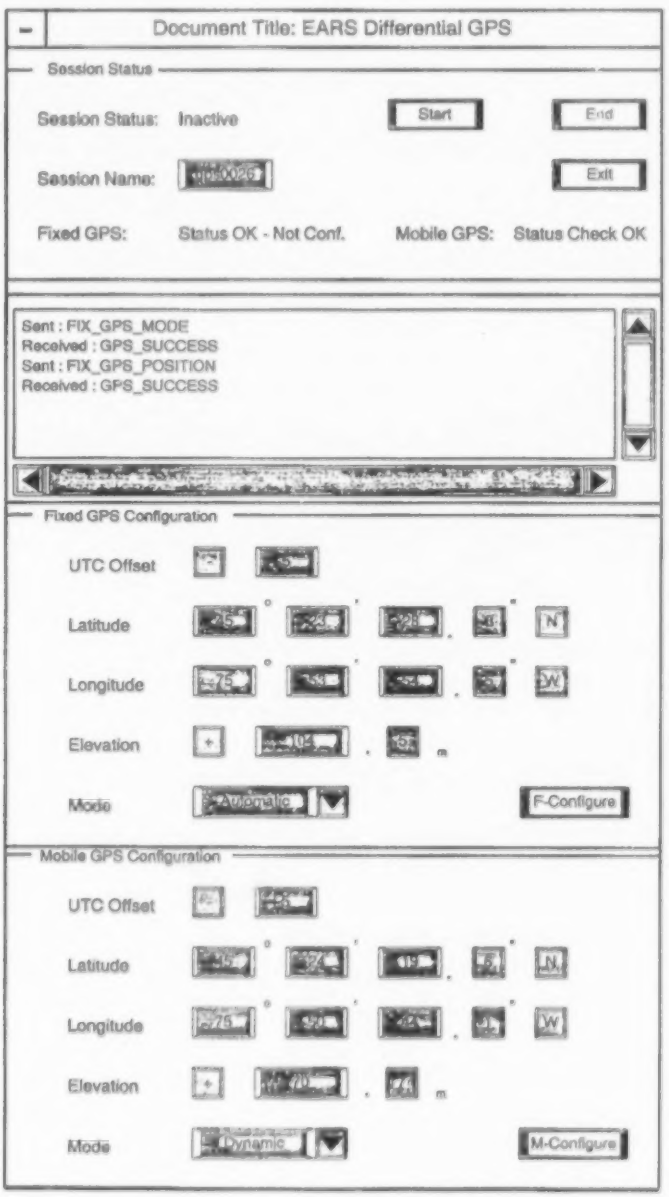


Figure 3-1 DGPS User Interface on the SUN Workstation

The DGPS task running on the CPU board manages the data collection from both GPS', and the data storage to a high-density DOS floppy. This task is automatically started with the other EARS application tasks when invoking the ***Con_EARS*** program from OS-9. ***Con_EARS*** can be started from the DLCS' remote terminal when logged-in as super user, by entering ***Con_EARS&*** at the OS-9 prompt. The program can also be invoked from the SUN, by entering ***telnet os9*** in a window shell, in order to link to the DLCS CPU board.

The DGPS window running on the SUN allows the user to command the collection of time and position from both the Fixed GPS and the Mobile GPS, and to store this information on a high-density DOS floppy.

The DGPS window can be invoked in two different ways from the Solaris operating system environment:

- From the ***/opt/home/operator/ears*** directory, by typing ***radar*** followed by the ***Enter*** key. This makes the DGPS window icon appear at the bottom left corner of the screen, along with all the other EARS application window icons.
- From the ***/opt/home/operator/ears/gps.dir*** directory, by typing ***dgps*** followed by the ***Enter*** key. This makes the DGPS window icon appear at the bottom left corner of the screen, but not the other EARS application window icons.

Once the DGPS icon appears, the DGPS window can be opened by clicking on it with the mouse's left button, and then selecting ***Restore***. The window can also be opened by double-clicking quickly on the icon.

Upon start-up, the DGPS program reads all the configuration parameters from the ***profile.gps*** profile file. These parameters include the ***Session Name***, and for both GPS units, the ***UTC Offset***, the ***Latitude***, ***Longitude*** and ***Elevation***, and the ***Mode***. All of them get displayed in the window as start-up parameters. Once the user terminates a session, the configuration parameters are stored back in the profile file.

3.1 DIFFERENTIAL GPS WINDOW

The DGPS window is shown in Figure 3-1. It is composed of four sub-windows, listed below.

3.1.1 Session Status

This sub-window allows the user to control the operation of the GPS data collecting sessions, with the aid of one configuration parameter, three indicators, and three buttons:

1- *Session Status*. This indicator tells the status of the session, either Inactive if not collecting any data, or Active if currently collecting data from both GPS units.

2- *Fixed GPS*, and

3- *Mobile GPS*. These two indicators tell the operating status of the Fixed GPS and the Mobile GPS, respectively. The status can either be:

- *Unknown* upon starting the window.
- *Status OK - Not Conf.* if the corresponding GPS unit is present but not configured.
- *Status Check OK* if the corresponding GPS unit is present and configured
- *Status Check Fail* if the corresponding GPS unit is absent

4- *Session Name*. This parameter sets the name of the session file, and the name of the two log files. The default name is gpsXXXXX, the five last characters being a number ranging from 00000 and 99999 and always incrementing from one session to the other. The user can change this default name with the mouse or the keyboard.

5- *Start*. This button allows to start a GPS data collecting session. It is enabled only when no session is taking place.

6- *End*. This button allows to stop a GPS data collecting session. It is enabled only while a session is taking place.

7- *Exit*. This button allows to exit the DGPS application window. It is always enabled, except while a session is taking place.

3.1.2 Monitoring

This untitled sub-window, located below the Session Status sub-window, monitors of the messages exchanged between the SUN workstation and the DLCS, and informs the user about current errors.

3.1.3 Fixed GPS Configuration

This sub-window allows the user to configure the Fixed GPS. Each of them provides the user with five configuration parameters, and one button. All the following configuration parameters within these sub-windows can be changed using the mouse or the keyboard.

1- *UTC Offset.* This parameter sets the Universal Time Coordinate (UTC) offset of the geographical location under test. The GPS unit uses this parameter to supply the local time.

2- *Latitude.* This parameter sets the latitude of the Fixed GPS' antenna, up to the tenth of a degree.

3- *Longitude.* This parameter sets the longitude of the Fixed GPS' antenna, up to the tenth of a degree.

4- *Elevation.* This parameter sets the elevation of the Fixed GPS' antenna, up to the tenth of a meter.

5- *Mode.* This parameter sets the Fixed GPS computational mode for positioning itself.

6- *F-Configure.* This button allows to send the configuration to the Fixed GPS.

3.1.4 Mobile GPS Configuration

Same as Fixed GPS, but for the Mobile GPS parameters.

3.2 MONITORING SUB-WINDOW

The DGPS window holds a sub-window to monitor the communication with the DLCS, and to report error conditions. Three kinds of status lines are displayed:

- *Sent Message:* This status line is displayed whenever a message is sent to the DLCS, to the attention of the GPS units. The sentence ***Sent:*** is displayed, followed by a message token. The following tokens are supported:

GPS_FILENAME:	Configures the filename for both the Fixed and the Mobile GPS'.
GPS_START:	Starts a GPS data collecting session.
GPS_STOP:	Stops a GPS data collecting session.
FIX_GPS_MODE:	Configures the Fixed GPS' positioning mode.
FIX_GPS_POSITION:	Configures the Fixed GPS' position.
FIX_GPS_STATUS:	Requests status from the Fixed GPS.
FIX_GPS_ZONE:	Configures the Fixed GPS' UTC zone.
MOB_GPS_MODE:	Configures the Mobile GPS' positioning mode.
MOB_GPS_POSITION:	Configures the Mobile GPS' position.
MOB_GPS_STATUS:	Requests status from the Mobile GPS.
MOB_GPS_ZONE:	Configures the Mobile GPS' UTC zone.

- *Received Message:* This status line is displayed whenever a message is received from the DLCS, about the GPS units. The sentence ***Received:*** is displayed, followed by a message token. The following tokens are supported:

GPS_FAILURE:	The action requested in the message previously sent has not been accomplished.
GPS_SUCCESS:	The action requested in the message previously sent has been accomplished successfully.
GPS_RAM_FAILURE:	The Fixed GPS detected a RAM memory failure.
GPS_CLK_FAILURE:	The Fixed GPS detected a Processor clock failure.
GPS_COMM_FAILURE:	The Fixed GPS detected a GPS engine communication failure.
GPS_OPER_FAILURE:	The Fixed GPS detected a GPS engine operational failure.
GPS_DAC_ERROR:	The Fixed GPS detected that DAC settings are near maximum or minimum.

- *Error Status:* This status line is displayed whenever the user tries to perform an invalid action. The only invalid actions supported are entering out-of-range parameters for the followings: UTC Offset, Latitude, Longitude, and Elevation.

3.3 GPS DATA COLLECTING SESSION

A GPS data collecting session consists of periodically polling every 2 seconds the time and the position from both GPS units, and storing this information in two ***log files***, one for each GPS unit, in ASCII format. The log files obtained share the ***Session Name*** parameter entered in the ***Session Status*** sub-window, with the addition of a ***.fix*** or a ***.mob*** extension.

In the log files, time information alternates with position information, and each of them is terminated with a Carriage Return - Line Feed. Here is an example of two consecutive lines within a log file:

```
14:25:36
N 45d23'27.5" W 75d53'56.1" +67m
```

The two log files are stored on the DLCS' system hard disk, in the ***/h0/EARS/GPS/DATA*** directory. At the end of the session, these files can be backed-up to a 3½ High-Density DOS floppy inserted in the DLCS' floppy drive. The back-up operation can be done from the SUN workstation, by opening a window to access the DLCS' OS-9 operating system. Once the window is opened, the following operations must be performed:

First open an Ethernet link to the DLCS, by entering:

```
telnet os9
```

At the ***login*** prompt, just press the *Enter* key

To go to the directory holding the log files:

```
chd /h0/ears/gps/data
```

To view the content of the directory:

`dir,` to get just the name of the files

`dir -e,` to get their size, date, owner and permissions

To copy the file named ***filename*** to the floppy:

```
copy filename -w=/p0
```

To close the link with the DLCS:

```
logout
```

At the end of a GPS data collecting, a ***session file*** is also created. The session file contains all the settings pertaining to the corresponding session. As for the log files, the session file shares the ***Session Name*** parameter entered in the ***Session Status*** sub-window, but it has a ***.sess*** extension. The session file can be used to relate the log files to the settings of a particular session. Here is an example of a session file's content:

```
Session date : Mon Aug 28 08:29:54 1995
Fixed latitude : 45 23′ 23.7″ N
Fixed longitude : 75 53′ 34.8″ W
Fixed elevation : 60.6 m
Fixed UTC offset : -4
Fixed mode : automatic
Mobile latitude : 45 23′ 25.6″ N
Mobile longitude : 75 53′ 32.9″ W
Mobile elevation : 63.7 m
Mobile UTC offset : -4
Mobile mode : automatic
```

The session file is stored on the SUN in ***the /opt/home/operator/ears/gps.dir/data*** directory, at the end of a session. This file can also be backed-up to a DOS diskette, by putting a diskette in the SUN's floppy drive and by invoking ***volcheck*** from a window shell. The diskette can then be accessed by using the descriptor ***/floppy/floppy0***.

The session file's directory can be accessed by using the ***cd*** command. To copy the session file named ***filename.sess***, enter:

```
cp filename.sess /floppy/floppy0
```

Once the copy is done, the diskette can be ejected by invoking ***eject***.

3.4 CONFIGURATION OF THE GPS UNITS

Prior to starting a DGPS session, the user must configure the two GPS units by using the DGPS application window. Each GPS unit requires to know the following parameters for its proper operation:

1- The UTC offset of the geographical zone under test

2- The positioning mode to use. The following modes are available:

- *Known.* In this mode, the GPS units do not compute the position, but only the time. This mode is efficient only if the antenna's position is accurately known and stable. Only one satellite is required. In the GPS-XL operating manual, this mode is referred to as the Time mode.
- *Survey.* In this mode, each GPS unit continually computes its antenna's position. This mode is efficient only if the position is not changing too fast. Three satellites or more are required. In the GPS-XL operating manual, this mode is referred to as the Survey Static mode.
- *Automatic.* This mode is a combination of the Survey and Known modes. The GPS units start computing their using the Survey mode algorithm. Once an

accurate position has been computed, the GPS units go in the Known mode. This process can take up to 24 hours.

- *Dynamic.* In this mode, the GPS units are allowed to move at high velocities while computing their positions. In the GPS-XL operating manual, this mode is referred to as the Survey Dynamic mode.

3- The antenna's position, either accurate or approximate. Configuring the GPS position shortens the calculation process. Note that the Fixed GPS effectively loads the new position only when placed in the Known positioning mode.

Once ready, the parameters can be sent to the proper GPS unit by clicking either the ***F-Configure*** button or the ***M-Configure*** button.

3.5 RUNNING A SESSION

A GPS data collecting session can start once both GPS' deliver accurate time and position. If the position of each GPS unit is already known, they can both be put in either the Known, Survey, or Dynamic mode, and the session can start as soon as they are configured. For the Fixed GPS, configuring the position requires the unit to be in the Known mode. Afterward the mode can be changed.

If the position of a GPS unit is not well known, it should be put in the Automatic mode, and left running for a while until the resulting position is stable. The position of the GPS unit can be monitored by performing dummy sessions, and by looking at the data obtained in the corresponding log file.

Ideally, both GPS units should operate in the same positioning mode, either Known, Survey, or Dynamic. This ensures that the two GPS units use similar positioning algorithms, therefore obtaining similar errors in their results. This condition is mandatory for the Differential GPS algorithms. The Automatic positioning mode is only useful to initialize the GPS units, and should not be used during a session since one unit might change to Known without the other.

The session can be stopped any time after it has been started, by clicking the *Stop* button. This produces two GPS log files on the DLCS' system controller hard disk, which can be backed-up to a 3½ High-Density DOS floppy. A session file is also generated on the SUN.

3.6 EXITING THE DIFFERENTIAL GPS WINDOW

The ***Exit*** button must be used to exit the DGPS window. If a session has taken place, all the parameters are saved in the profile file with their new values, ready for the next sessions to come.

4. TROUBLESHOOTING

Consult this section whenever the GPS Unit does not communicate with the remote host (the user receives an error message whenever a command is issued to the GPS Unit).

The GPS Unit is configured to automatically send a "GPS UNIT READY" message 4 to 6 seconds after power-up, and enter a wait mode. If no messages are sent to the host, remove all power from the GPS Unit (connections with the battery packs) and re-establish power. If the unit still does not send any message, follow the troubleshooting procedure below.

For troubleshooting, you will need a PC with a 9-pin serial port, or a 25-pin to 9-pin adapter, if the PC is configured with a 25-pin serial port. You will also need to determine the port number (COMx:) and use a terminal emulation software, such as PROCOMM.

4.1 POWER

The battery pack shall supply voltage between 10 and 14 volts. If the voltage is outside that range, the Mobile GPS may not operate reliably. One red LED indicates that the board is powered by at least one battery pack.

If the battery is within the specified range and the red LED is on, monitor the test points to determine the voltages on the Power Supply Board.

Test Point	Voltage
TP1	+12 volts
TP2	+5 volts
TP3	GND
TP4	+6.6 volts

If the red LED is off or one of these test points does not correspond to the specified values, please contact MultiDev for repair.

The voltages can be monitored at the host station. Consult the Operation section for additional information about monitoring the GPS Unit voltages.

If the voltages are within the specified range, continue below.

4.2 MICRO PC

The Micro PC is configured to automatically run the GPS program. To verify its operation, the PC used for troubleshooting connects to the Micro PC via a ribbon cable supplied with the GPS Unit.

- Unplug the PC-to-modem cable at the Micro PC end.
- Connect the 10-pin end of the ribbon cable to Port 1 of the Micro PC.
- Connect the DB-9 end of the ribbon cable to the PC used for troubleshooting.
- Load the terminal emulation software on the PC and configure the 9-pin serial port as "COMx: 9600,n,8,1", x being the port number.
- Reset the Micro PC by pushing the RESET button on the Micro PC.

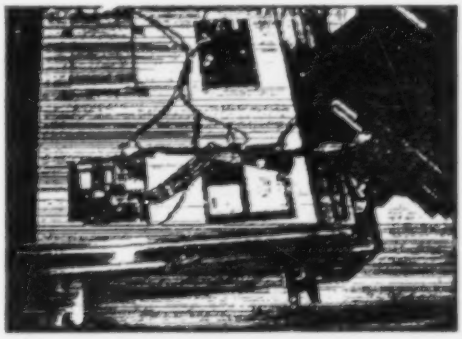


Figure 4-1 Micro PC to PC connection

- The last message on the screen should be "GPS UNIT READY", after 4 to 6 seconds.
- If there is no message, the Micro PC needs to be repaired. Refer to the Micro PC manual.
- If there is a message, send the command "F50<cr>". The position of the GPS antenna should be displayed in the format below (format may vary):

```
F50 N 45d23'27.5" W 075d53'55.2"    36m pdop  0.00
```

- If there is no response, refer to the GPS-XL section below.
- If there is a response, refer to the Modem section below.

4.3 GPS-XL

The GPS-XL board can be accessed directly without the help of the Micro PC.

- Remove power from the GPS-XL board (unplug the power cable).
- Unplug the PC-to-GPS cable at the GPS-XL end.
- Connect the 10-pin end of the ribbon cable to the GPS-XL.
- Connect the DB-9 end of the ribbon cable to the PC used for troubleshooting.
- Load the terminal emulation software on the PC and configure the 9-pin serial port as "COMx: 9600,e,7,1", x being the port number.
- Reinstall the power cable.
- A time reference in the format below should be displayed every second (format may vary).

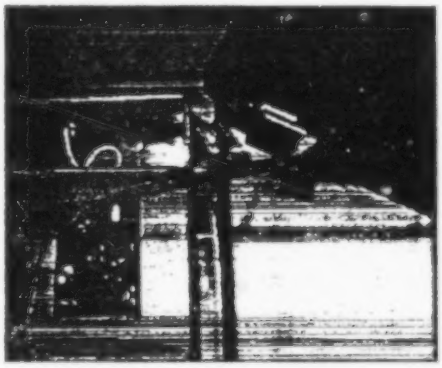


Figure 4-2 GPS-XL to PC connection

```
218:12:00:29?
```

- If there is no message, the GPS-XL is defective.
- If the displayed message is corrupted, verify the serial port set-up on the PC. Otherwise, the GPS-XL is defective.
- To verify the functionality of the GPS-XL, send <control-c> to the GPS-XL and send a position command "F50<cr>". The message should be in the following format (format may vary):

```
F50 N 45d23'27.5" W 075d53'55.2"    36m pdop  0.00
```

4.4 MODEM

The modem can be accessed using the round cable supplied with the GPS Unit.

- Remove power from the modem (unplug the power cable).
- Unplug the PC-to-modem cable at the modem end.
- Connect the 25-pin end of the round cable to the modem.
- Connect the DB-9 end of the round cable to the PC used for troubleshooting.
- Load the terminal emulation software on the PC and configure the 9-pin serial port as "COMx: 9600,n,8,1", x being the port number.

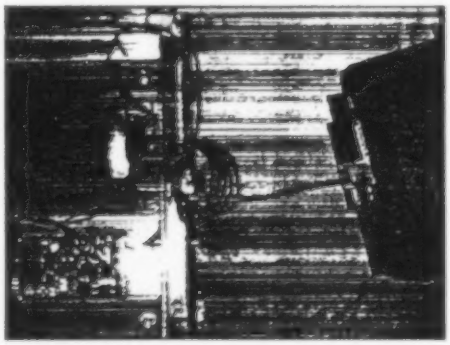


Figure 4-3 Modem to PC connection

- Reinstall the power cable.
- Send a "+++" sequence to exit the data mode (Hayes standard).
- Wait for the "OK" message. If there is no message, try the message "AT". If there is no answer, the modem is defective.
- Send the command "AT&V". The modem configuration should be as follow:

```
E1
&C0 &D0 &K1 &M0
S002:043 S003:013 S004:010 S005:008 S012:050 S050:000
S051:085 S052:137 S053:001 S054:002 S055:120 S056:255
S057:001 S058:001 S059:001 S060:001 S061:053 S062:069
S063:xxx S064:012 S065:000 S066:050 S067:000 S068:010
S069:008 S070:001 S071:000 S073:020 S080:000 S081:001
S082:000 S083:001 S084:000 S085:001 S086:001 S087:001
S088:001 S089:001 S090:000 S091:000 S096:004
OK
```

- If the configuration is different, you need to reconfigure the modem as per the above configuration. To reconfigure the modem, read the instructions in the Utilicom User's Manual.

5. MICRO PC PROGRAMMING

The Micro PC program can be changed by reprogramming the Flash EPROM based disk E. The Micro PC comes with utility software that can make a copy of the executable files from a floppy disk on your PC to disk E of the Micro PC.

If you recompile a new GPS program and want to download it to the Micro PC, the following steps shall be followed:

- Use the ribbon cable supplied with the GPS Unit and connect the Micro PC to a host PC.
- Copy all files of the Micro PC 5012A/6012 ROM-DOS disk supplied with the GPS Unit to your hard disk in directory x:\MICROPC. *This program is for use with the GPS Unit only.* ***Do not use this disk for any other purpose.***
- Go to this directory and call the SL program.
- Remove the jumper BOOT on the Micro PC.
- Reset the Micro PC.
- You should be communicating with the Micro PC in DOS mode.
- Type "DISKSAVE" and hit F9 on the keyboard.
- Type "DISKSEND" and enter the floppy disk drive letter on your PC. If another port than COM1 is used, type "DISKSEND /Cx", x being the port number.
- All programs in the floppy should be downloaded onto the Flash EPROM (drive E: of the Micro PC) if there is sufficient space.
- Type "EXIT" and return to the Micro PC DOS.
- Type "DIR E:" The programs in the floppy disk should now be in drive E: of the Micro PC as well.
- Replace the jumper BOOT.
- Reset the Micro PC. The new program should execute.

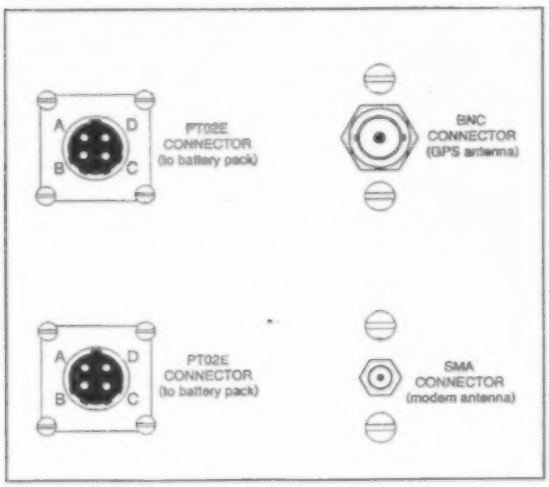
6. SPECIFICATIONS

Operating Temperature:	0 to 50 °C
Operating Voltage:	10 to 14 volts
Power Requirements:	1.6 A @ 12 volts (approx. 20 w)
Operating Range between GPS Unit and Host:	up to 15 km (as per Utilicom's specifications)

For the TrueTime's GPS-XL, Octagon's Micro PC and Utilicom's wireless modem specifications, please refer to supplier's documentation

7. GPS UNIT ASSEMBLY

7.1 CONNECTORS

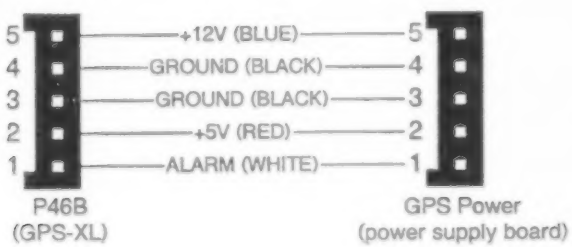


PT02E Connectors	
A	+12V
B	N.C.
C	N.C.
D	GND

Figure 7-1 Bottom View of the GPS Unit Enclosure

7.2 CABLES

7.2.1 GPS Power Cable (Power Supply Board to GPS-XL)



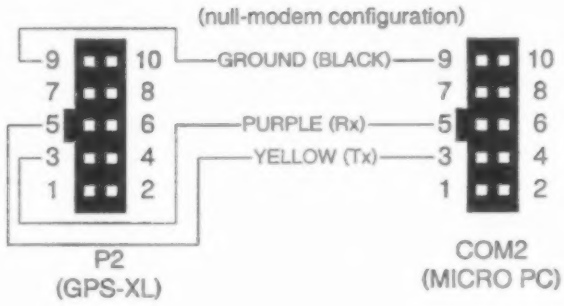
7.2.2 Micro PC Power Cable (Power Supply Board to Micro PC)

RED	+5V
BLACK	GROUND

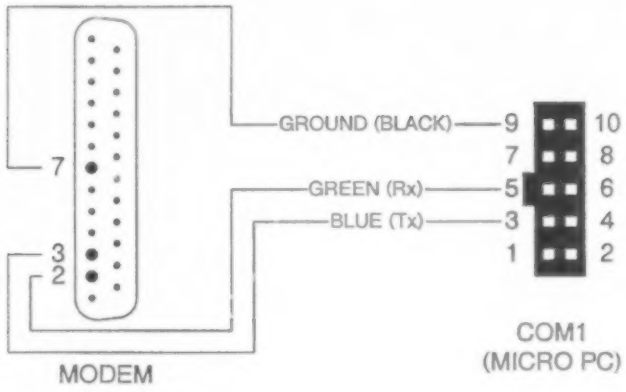
7.2.3 Modem Power Cable (Power Supply board to modem)

RED	+6.6V
BLACK	GROUND

7.2.4 PC-to-GPS Cable



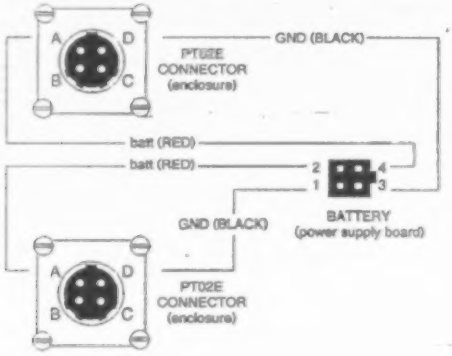
7.2.5 PC-to-modem Cable



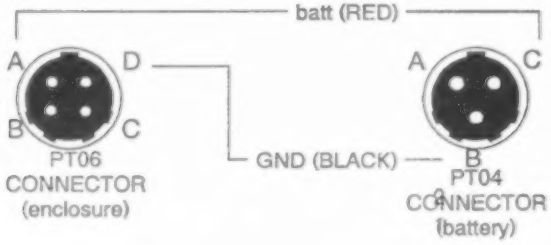
7.2.6 Monitor Cable

The monitor cable is the rainbow colored ribbon cable that plugs between the Power Supply Board (Analog Monitor) and the Micro PC (Analog IN). The pin-out is a one-to-one configuration.

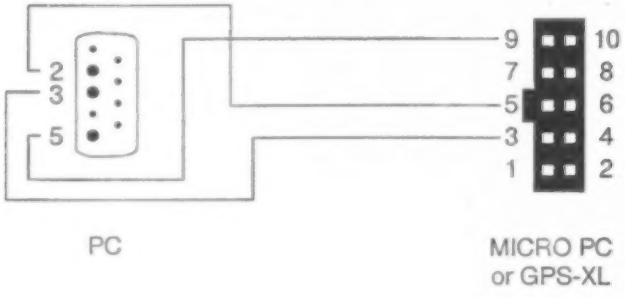
7.2.7 Power Supply Cable



7.2.8 Battery Cable



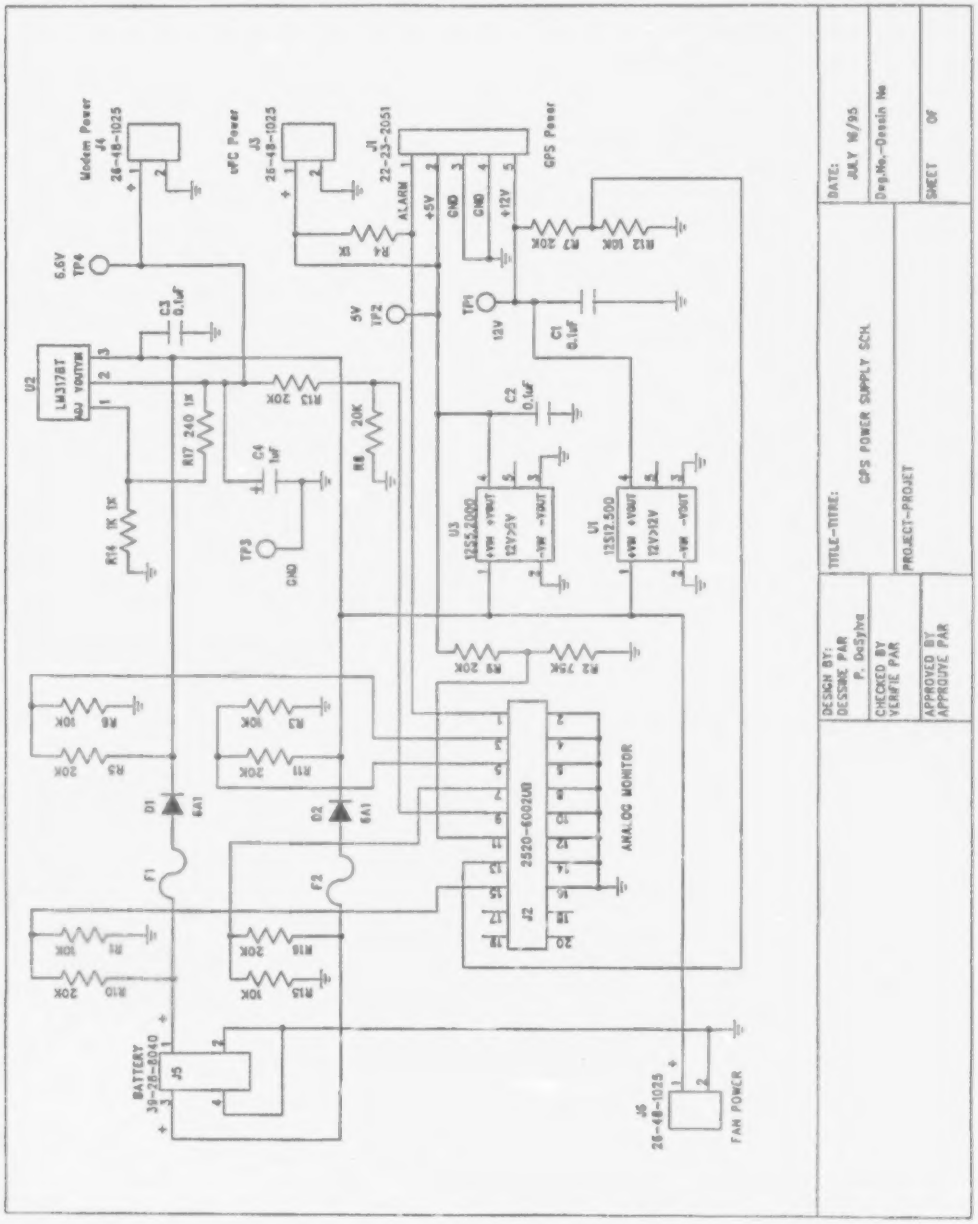
7.2.9 Test Cable 1 (Ribbon Cable)



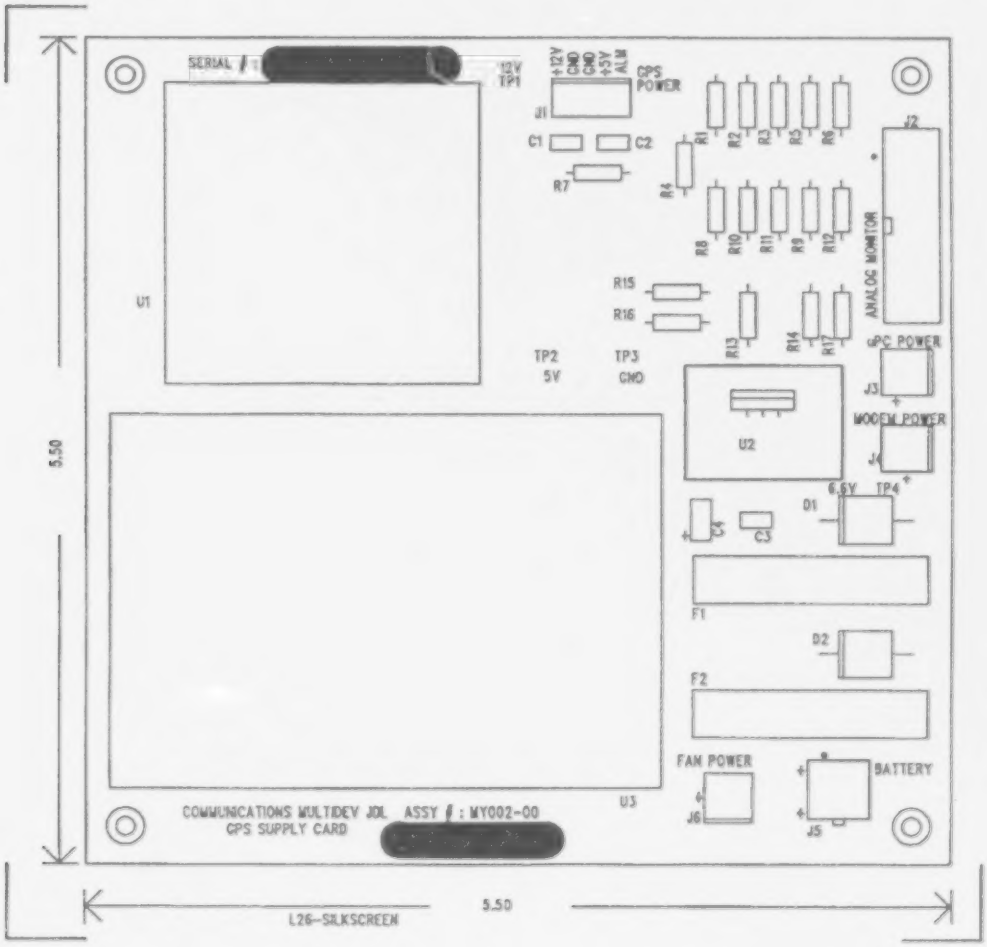
7.2.10 Test Cable 2 (Round Cable)

The round cable is a standard PC-AT to modem cable.

7.3 POWER SUPPLY SCHEMATICS



7.4 POWER SUPPLY LAYOUT



7.5 POWER SUPPLY BOARD - PARTS LIST

Bill Of Materials on Sun Jul 16 22:48:36 1995

Item	Qty	Reference	Part Name	Manufacturer	Description
1	1	U1	12S12.500		6 WATT DC/DC CONVERTER
2	1	U3	12S5.2000		12 WATT DC/DC CONVERTER
3	1	J1	22-23-2051		22-23-2051
4	1	J2	2520-6002UB		
5	3	J3-4 J6	26-48-1025		STRAIGHT PIN FRICTION LOCK HEADER .156 Centers
6	1	J5	BATTERY		
7	1	C4	CAP+,1uF		DECOUP CAP RADIAL BODY:.270 X.130 CENTERS:.200
8	3	C1-3	CAP\0.1UF, 0.1uF		CAP RADIAL BODY: .200 X.100 CENTERS: .100
9	2	D1-2	DIODE6A1		?
10	2	F1-2	FUSE		
11	1	U2	LM317BT		
12	5	R1 R3 R6 R12 R15	R1/4W,10K		RES BODY:100 CENTERS:500
13	1	R4	R1/4W,1K		RES BODY:100 CENTERS:500
14	1	R14	R1/4W,1K 1%		RES BODY:100 CENTERS:500
15	8	R5 R7-11 R13 R16	R1/4W,20K		RES BODY:100 CENTERS:500
16	1	R17	R1/4W,240 1%		RES BODY:100 CENTERS:500
17	1	R2	R1/4W,75K		RES BODY:100 CENTERS:500
18	4	TP1-4	TESTPOINT		

7.6 MOBILE GPS - PARTS LIST

QTY	PART NUMBER	DESCRIPTION	MANUFACTURER	SUPPLIER
ENCLOSURE				
1	1418 N4 AL E6	20" x 24" enclosure	Hammond	Electrosonic
MICRO PC				
1	3476	6012-1MB, CPU board	Octogon Systems	Multilek
1	3455	PC Smartlink IV	Octogon Systems	Multilek
1	3495	256K flash EPROM	Octogon Systems	Multilek
1	2746	VTC-9F serial cable	Octogon Systems	Multilek
POWER SUPPLY BOARD				
1		supply board PCB	----	Pricon
1	26-48-1025	10 pcs, 2-pin conn. male header (0.156)	Molex	Newark
10	313005	5A, 3AG, SLO-BLO fuses	LittleFuse	Newark
3	LM317BT	positive adj. voltage regulator	Motorola	Newark
5	6A1	6A, 100V diode	Diodes Inc.	Electrosonic
1	12S12 500	DC/DC converter 12V -> 12V, 500 mA	Astec	Electrosonic
1	12S5 2000	DC/DC converter 12V -> 5V, 2000 mA	Astec	Electrosonic
1	1508-2	100 pcs, test points	Keystone	Electrosonic
2	2520-6002UB	20-pin header, .1 x .1	3M	Electrosonic
1	22-23-2051	10 pcs, 5-pin conn. male header (0.156)	Molex	Newark
1		1uF capacitor		
3		.1uF capacitor		
5		10 KΩ resistor		
2		1 KΩ resistor		
8		20 KΩ resistor		
1		240 Ω resistor		
1		75 KΩ resistor		
CABLES AND ASSEMBLY				
50	08-56-0110	pins for 0.1 female housing	Molex	Newark
50	08-58-0122	pins for 0.156 female housing	Molex	Newark
10	09-50-8023	2 pin conn. female housing (0.156)	Molex	Newark
1	1-66506-0	100 pcs, D-sub crimp gold pins	AMP	Newark
5	102387-1	10-pin, Conn. housing	AMP	Newark
2	17-D20418-2X	D-sub lock assembly female	Amphenol	Newark
3	205208-1	25-pin D-sub plug	AMP	Newark
1	22-01-3057	10 pcs, 5-pin conn. female housing	Molex	Newark
3	342014A	fuse holder	LittleFuse	Newark
5	3448-4626	strain relief, 26-pins, for panel conn.	3M	Newark
5	3448-4650	strain relief, 50-pins, for panel conn.	3M	Newark
5	3448-4660	strain relief, 60-pins, for panel conn.	3M	Newark
100	3518	snap-in polarization key	3M	Newark
5	4626-6000	panel shrouded header, 26 pins	3M	Newark
5	4650-6000	panel shrouded header, 50 pins	3M	Newark
5	4660-6000	panel shrouded header, 60 pins	3M	Newark
100	90F5675	Mod IV receptacle contacts	AMP	Newark
2	31-161-0	DC power plug, 3mm short barrel	Mode Elect.	Electrosonic
5	4245	3AG fuse holder	Keystone	Electrosonic
1	83264-100	RG179 coaxial cable	Belden	Electrosonic
2	31-123-0	DC power plug, 2.1mm short barrel	Mode Elect.	Electrosonic
3	3421-6600	20-pin ribbon conn.	3M	Electrosonic
3	3448-3020	strain relief clip	3M	Electrosonic
25	3490-2	ribbon conn. pull tab	3M	Electrosonic
1	BRA1CPLG	brass collar	----	Westburne
2	NIP1X6BRA	brass nipple	----	Westburne
2	PVC1 1/2x1BUSHF80	bushing	----	Westburne
2	PVC1 1/2FLASHW80	flange	----	Westburne
1	COLPVC40125ML	collar	----	Westburne
3	3334-6000	60-pin ribbon conn.	3M	Newark
3	3425-6000	50-pin ribbon connector	3M	
10	2-221128-1	50 Ohm BNC hex crimp conn.		
3	3448-3050	strain relief clip, 50-pin	3M	
3	3448-3060	strain relief clip, 60-pin	3M	
1	46N7369	"N" in-line plug/plug	SPC Technology	
5	90F2518	cable straight SMA conn.	ITT Sealec.	
1	WLI-04-017-SC	100 pcs., No. 4 lock washers		
2	PT06E-12-3P (SR)	4-pin circular conn. female		
2	PT06E-12-4S (SR)	4-pin circular conn. male		

8. MOBILE GPS CONFIGURATION PARAMETERS

The Micro PC inside the Mobile GPS configures some of the components and functions internal to the Mobile GPS. They are listed below:

8.1 MICRO PC COMMUNICATION PORTS

Set-up of the modem communications port COM1.

8 BITS
NO PARITY
1 STOP BIT
9600 BAUD RATE

Set-up of the GPS communications port COM2.

7 BITS
EVEN PARITY
1 STOP BIT
9600 BAUD RATE

8.2 MODEM CONFIGURATION

The user-defined modem configuration is as follows (S registers):

```
S50     0                               ;no 14-bit address code
S51     85                              ;7-bit address code
S52     10001001 (0x89, or 137)
        |  || ||____;7-bit address enabled
        |  ||_______;error detection enabled
        |  |________;retry enabled
        |___________;power up in data mode
S53     1                               ;one byte in Tx buffer
S54     2                               ;time-out is 40 msec
S55     120                             ;120 characters in the Tx buffer
S56     255                             ;maximum transmit power
S57     1                               ;15.873 Kb/s transmit rate
S58     1                               ;15.873 Kb/s receive rate
S59     1                               ;transmit spreading code 1 (?)
S60     1                               ;receive spreading code 1 (?)
S61     53                              ;transmit channel is 908.3 MHz
S62     69                              ;receive channel is 909.9 MHz
S63     ----                            ;RF signal strength
S64     12                              ;transmit preamble
S65     0                               ;receive frequency offset
S66     50                              ;receive frequency bandwidth
S67     ----                            ;actual received frequency offset
S68     10                              ;transmit retry time-out of 200 msec
S69     8                               ;8 retransmission attempts
S70     1                               ;delay of 5 msec between Rx and Tx
S71     0                               ;no collision avoidance delay
S96     4                               ;9600 baud
```

8.3 MICRO PC AtoD CONFIGURATION

The AtoD is configured as unipolar and single ended mode.

The reading of each of the 8 analog channels is in the following format:

```
F98 CH1=xxxx CH2=xxxx CH3=xxxx CH4=xxxx CH5=xxxx CH6=xxxx CH7=xxxx CH8=xxxx <cr><lf>
```

Each channel monitors a different test point on the PCB:

channel 0 = GPS alarm	4096 = alarm	0000 = no alarm
channel 1 = power LED	1400 = LED OK	batt = LED is defective
channel 2 = +12V supply	batt = power	0000 = unit is not powered
channel 3 = battery 1	batt = present	0000 = no battery 1
channel 4 = modem power	2700 = power	0000 = modem is not powered
channel 5 = PC power	3200 = power	0000 = PC is not powered
channel 6 = GPS power	3250 = power	0000 = GPS is not powered
channel 7 = battery 2	batt = present	0000 = no battery 2

* values may vary within an acceptable range of +/- 150

** value "batt" indicates that the reading is for a battery that can range between +10V and +14.5V. 2700 is the minimum (+10V) and 4000 is the maximum (+14.5V). */

9. REFERENCES

[1] *Development of an Enhanced Signal Processing Data Acquisition and Display System,* MultiDev JDL Communications Inc., April 1995.

[1] *Development of an Enhanced Signal Processing Data Acquisition and Display System,* MultiDev JDL Communications Inc., April 1995.

[2] *Model GPS-VME 560-5604 Operator's Manual*, TrueTime Inc., May 1993.

[3] *Model GPS-XL 87-625 Operator's Manual*, TrueTime Inc., May 1995.

[4] *LongRanger 2000/ISM900-1 Spread Spectrum Modem Operator's Manual*, Utilicom Spread Spectrum Communications.

[5] *LongRanger Operation and Communication Protocol Specification,* Utilicom Spread Spectrum Communications, January 1995.

[6] *Micro PC 6012 User's Manual,* Octagon Systems Corporation, doc. #03499 Rev. 0295, February 1995.

[7] *PC SmartLink IV Utility Software for the IBM PC*, Octagon Systems, doc. #03449 Rev. 0993, September 1993.

[8] *Differential Global Positioning System Design Document,* MultiDev JDL Communications Inc., MD002-02, July 1995.

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A Differential Global Positioning System will be installed into EARS: one GPS (the fixed GPS) will reside inside EARS and will indicate the position of the radar; the other GPS (the mobile GPS) will be located beside a radar target during trials and will provide position of the mobile target.

The purpose of the Differential GPS is to measure and record the location, in both time and space domains, of the radar target during EARS' trials. This information can be used afterwards, along with the collected data, to relate the time with the position of the target, and ultimately to evaluate the performances of the radar algorithms.

This document describes the operation and troubleshooting of the Differential Global Positioning System (DGPS) to be used in the Data Logger and Control System of the Experimental Array Radar System. The document includes a detailed description of how to install the equipment and the software, how to operate the equipment with the user interface installed on the host workstation (SUN workstation), and how to troubleshoot and reconfigure the equipment in case of failure or need to modify its operation.

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EARS, Experimental Array Radar System
DATA ACQUISITION
REAL TIME PROCESSING
GLOBAL POSITIONING SYSTEM (GPS)
DIFFERENTIAL GLOBAL POSITIONING SYSTEM (DGPS)
VMEBUS
SUN WORKSTATION
WIRELESS MODEM
SINGLE BOARD COMPUTER
STATIC AND DYNAMIC SURVEY
DIGITAL SIGNAL PROCESSING
ANTENNA
GRAPHICAL USER INTERFACE

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